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R.C. VAN DIJK

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GENERATION OF PACKETS OF WAVEFORMS

FIELD OF THE INVENTION

This invention relates to a method and apparatus for generating packets, or sequences, of waveforms, for example to be utilized in obstacle-detection systems and particularly, but not exclusively, in automotive blind-spot or pre-crash warning systems designed to operate in multiuser environments.

BACKGROUND OF THE INVENTION

One important type of automotive blind-spot or pre-crash warning system employs short pulses of electromagnetic or ultrasonic energy to interrogate the detection zone. A decision regarding the presence or absence of an obstacle at a predetermined range is then made by suitably processing energy backscattered by various objects in the field of view of the system.

Fig. 1 is a block diagram of a typical obstacle-detection system utilizing short pulses of electromagnetic energy. The system comprises a pulse generator PGR that produces repetitively pulses with duration T_P so selected as to provide a required range resolution ΔR. The pulse repetition period T_{REP} may be constant or may vary in some specified manner. The system also has an oscillator OSC that generates a sinusoidal signal with a required carrier frequency, a pulse modulator PMD that modulates the carrier signal in an on-off fashion, a power amplifier PAM that amplifies the pulsed carrier signal to a required level, a transmit element TEL that

radiates pulses of electromagnetic energy towards an obstacle OBS, a suitable receive sensor REL that receives electromagnetic pulses reflected back by the obstacle OBS, an input amplifier IAM that amplifies the signal provided by the receive sensor REL, a signal conditioning unit SCU that employs suitable signal processing to shape the received pulses, and a pulse-coincidence processor PCP that processes jointly the reference pulses supplied by the generator PGR and reconstructed pulses supplied by the signal conditioning unit SCU to provide a decision DEC regarding the presence or absence of an obstacle at a predetermined range.

Fig. 2 depicts a periodic pulse train comprising rectangular pulses of duration T_P and repetition period T_{REP}. The range resolution depends on the pulse duration T_P, and the unambiguous range of the system depends on the period duration T_{REP}.

In some applications, it is useful to blank the input amplifier IAM during pulse transmission intervals, in order to suppress an undesired leakage signal originating in the transmitter. The required blanking function is accomplished by applying pulses provided by the generator PGR to the blanking input BI of the amplifier IAM.

Fig. 3 is a block diagram of a multichannel pulse-coincidence processor PCP utilized by the obstacle-detection system of Fig. 1. The processor has a decision block DBK and a plurality of channels, each comprising a suitable delay unit

DELN, a coincidence gate CG and a coincidence counter CCR. The plurality of delay values, DEL1, DEL2, ... , DELJ, corresponds to a plurality of range values of interest, referred to as range gates. In each channel, reference pulses provided by PGR are suitably delayed and applied to one input of CG, whose other input is driven by pulses reconstructed by signal conditioning unit SCU. When a pulse coincidence occurs, the counter CCR adds a one to the already accumulated number of coincidences. At the end of a prescribed observation period, each coincidence counter CCR supplies the number G of accumulated pulse coincidences to the decision block DBK.

When it is known (e.g., from geometric/physical considerations) that at most one obstacle may be present in the field of view of the system, the decision block DBK selects the greatest of the supplied numbers, G1, G2, ... , GJ, and compares this maximum value with a suitable decision threshold DT. If the decision threshold has been exceeded, then the DBK declares, at the output DEC, an obstacle present in the range gate that exhibits the greatest number of observed coincidences.

Alternatively, when multiple obstacles may be present in the field of view of the system, the decision block DBK compares *all* supplied numbers, G1, G2, ... , GJ, with a suitable decision threshold DT. If the decision threshold has been exceeded in some range gates, then the decision block DBK declares, at the output DEC, obstacles present in those range gates.

In some applications, especially when multiple obstacles are to be detected, an improved detection performance can be achieved by replacing in the pulse-coincidence processor PCP each coincidence gate (CG) and the associated coincidence counters (CCR) by an analogue-to-digital-converter followed by a digital accumulator. The resulting arrangement will become sensitive to the relative strength of backscattered pulses, thereby capable of providing a better detection performance. Such a modified version of the pulse coincidence processor (PCP) can be viewed as a multichannel parallel digital correlator.

An important simplification of the modified PCP will be obtained by replacing each coincidence gate (CG) by an analogue sampling circuit (SC) and by implementing the accumulation operation (performed by a counter CCR or a digital accumulator) in an analogue fashion with the use of a suitable integrator (INT). Fig. 4 is a block diagram of such simplified system. Two basic forms of an analogue integrator, an *integrate-and-dump* circuit and a *running-average* integrator, are known to those skilled in the art.

It is known that object detectability can be improved significantly, when a single pulse is replaced by a suitably-constructed pulse packet. Consequently, a basic periodic pulse train, such as one depicted in Fig. 2, can be replaced by a sequence of successive pulse packets.

In this arrangement, each pulse packet comprises a specified number N of identical pulses which are staggered nonuniformly, with each interpulse spacing being an integer multiple of a suitably chosen unit time interval. The pattern of interpulse spacings is so designed as to ensure that only a small number h_a of pulse coincidences (preferably at most one pulse coincidence) will occur between a primary pulse packet and its replica shifted in time by more than one pulse duration. This condition is usually referred to as the *autocorrelation constraint.*

Consider a pulse packet of span (length) L comprising N identical rectangular pulses of unit duration. Such a pulse packet can be conveniently represented by a binary sequence $\{x\} = x_1\ x_2 \ldots\ x_L$ of symbols 0 and 1, in which symbol 1 corresponds to pulse occurrence. In this case, the autocorrelation constraint can be expressed as

$$R_{xx}(d) = \sum_{i=1}^{L-d} x_i x_{i+d} \leq h_a < N, \quad 0 < d \leq L-1$$

where $R_{xx}(d)$ is the autocorrelation sequence and d is the integer shift. When $d = 0$, the autocorrelation value $R_{xx}(0)$ simply equals the number N of pulses contained within the pulse packet.

In the class of all pulse packets with a specified number of pulses N and $h_a = 1$, a *maximally compact* pulse packet has the minimal span L_{min}. Consequently, the maximally compact pulse packet exhibits the largest duty factor, N / L, hence the largest average power. For a fixed N and $h_a = 1$, all pulse packets with spans greater than L_{min} are referred to as *sparse* pulse packets.

Fig. 5 depicts a pulse packet of span L = 36 comprising N = 8 pulses which are placed at locations 1, 8, 11, 17, 19, 31, 32 and 36. The pulse packet can be represented by the following binary sequence {x}

{x} = 100000010010000010100000000000110001

The autocorrelation sequence $R_{xx}(d)$ of {x} is shown in Fig. 6(a). The peak value of $R_{xx}(d)$ occurs at zero shift and $R_{xx}(0) = 8$; for other shifts d, the function $R_{xx}(d)$ assumes values either zero or one ($h_a = 1$). While the autocorrelation sequence $R_{xx}(d)$ fully characterises the binary sequence {x}, the corresponding pulse packet is usually characterised by the autocorrelation function $R_{xx}(\tau)$, where the parameter τ denotes continuous time delay (shift). The autocorrelation function $R_{xx}(\tau)$ of the pulse packet represented by {x} is shown in Fig. 6(b), where Δ denotes the unit time interval. Both the autocorrelation sequence $R_{xx}(d)$ and the autocorrelation function $R_{xx}(\tau)$ are even functions of their respective arguments.

The autocorrelation constraint ensures that when there is no noise or interference, and a multichannel pulse-coincidence processor is used for detecting a pulse packet, the output of each channel is at most h_a except when the channel delay matches that of a pulse packet being received. In this case, the channel output reaches the peak value of N.

In practical systems, in order to suppress undesired leakage from the transmitter, the receiver is usually blanked during pulse transmission intervals. The autocorrelation

constraint $R_{xx}(d) \leq 1$ implies that when the pulse packet being received overlaps the pulse packet being transmitted, at most one received pulse in a target return will be lost.

In a multiuser environment, the users may transmit their signals simultaneously and asynchronously so that not only must each receiver recognize and detect its own transmitted signal, but it must be able to do so in the presence of the other transmitted signals. Assume that a pulse packet to be detected by a receiver of interest is represented by a binary sequence

$$\{x\} = x_1 x_2 \ldots x_L$$

and that one of the interfering pulse packets is represented by another binary sequence

$$\{y\} = y_1 y_2 \ldots y_L$$

In order to optimize the detection performance of the receiver in multiuser environment, the following *cross-correlation constraints* must be satisfied for all integer shifts d

$$R_{xy}(d) = \sum_{i=1}^{L-d} x_i\, y_i + d \leq h_c < N, \quad 0 \leq d \leq L-1 \text{ and}$$

$$R_{yx}(d) = \sum_{i=1}^{L-d} y_i\, x_i + d \leq h_c < N, \quad 0 \leq d \leq L-1$$

When more than one transmitter is in operation, the autocorrelation and cross-correlation constraints combined together ensure that when there is no noise and a multichannel pulse-coincidence processor is used for detection, the output of each

channel is still substantially less than N except when the channel delay matches that of a received pulse packet of interest.

Various techniques have been developed to construct sets of binary sequences with good autocorrelation and cross-correlation properties (see for example, P. Fan and M. Darnell, *Sequence Design for Communications Applications*. Wiley, 1996). However, these are generally only of limited use in automotive obstacle-detection systems designated to operate in multiuser environment, as they would produce multiple different long sequences exhibiting a very low duty factor, hence the resulting detection performance will be significantly degraded.

In automotive applications, many similar obstacle-detection systems should be capable of operating in the same region, also sharing the same frequency band. To avoid mutual interference, each system should use a distinct signal, preferably uncorrelated with the signals employed by all other systems. Because it is not possible to predict which of the many similar systems will be operating in a particular environment, it is not practical to assign a distinct binary sequence to each of them. Furthermore, it is also very difficult to construct large sets of binary sequences with good autocorrelation and cross-correlation properties, and also exhibiting acceptable duty factors.

European Patent Application No. 02250394.0 (referred to herein as "the earlier application") discloses a method which exploits random mechanisms to generate

large sets of composite pulse trains that can satisfy both autocorrelation and cross-correlation constraints. Consequently, resulting composite pulse trains will exhibit an excellent resistance to mutual jamming in multiuser environments.

According to the method disclosed in the earlier application, a composite pulse train consists of a sequence of primary pulse packets each of which is drawn at random from a predetermined set of suitably constructed primary pulse packets with prescribed autocorrelation and cross-correlation properties. The autocorrelation function of each primary pulse packet exhibits the property of 'at most one coincidence'. Also, the cross-correlation function between any two different pulse packets assumes small values compared to the maximum value of the corresponding autocorrelation functions.

For example, a primary pulse packet with desired autocorrelation properties can be used to construct another primary pulse packet with the same autocorrelation properties by reversing in time the first primary pulse packet. The cross-correlation function between these two dual primary pulse packets will not exceed values greater than two.

Fig. 7(a) shows an example of a primary pulse packet, and Fig. 7(b) shows another primary pulse packet, being a mirror image of the first packet. Fig. 8 depicts cross-correlation between two binary sequences that represent those two pulse

packets. The cross-correlation function is asymmetric and it assumes, for different shifts, one of three values, 0, 1, or 2.

According to the method disclosed in the earlier application, the resistance to mutual jamming in multiuser environments can be further improved by separating individual primary pulse packets by gaps of random duration, the value of which may be determined by a random value supplied by a random number generator. Fig. 9 depicts the structure of such constructed composite pulse trains.

As a result, although each user may have the same set of primary pulse packets, a composite pulse train *transmitted* by each user is assembled in a random manner and is, therefore, statistically unique.

Although the method disclosed in the earlier application offers a practical solution to the problem of alleviating the mutual interference effects in a multiuser environment, the method is not capable of increasing the ratio **R** of the peak autocorrelation value, $R_{xx}(0) = N$, to the maximum (unit) autocorrelation sidelobe value. Increasing the value of **R** would improve the capability of the obstacle-detection system to detect and discriminate smaller obstacles (such as motorbikes) located in proximity of larger obstacles (such as trucks).

It would therefore be desirable to provide a method for generating a large number of pulse trains with good autocorrelation properties, good cross-correlation properties,

and also improved capability to discriminate between smaller and larger obstacles, especially for applications in systems intended to operate in a multiuser environment.

DESCRIPTION OF THE INVENTION

Aspects of the present invention are set out in the accompanying claims.

According to a further aspect of the invention, a pulse packet is constructed in such a way as to satisfy the autocorrelation constraint modified as follows

$$R_{xx}(d) = \sum_{i=1}^{L-d} x_i\, x_i + d = 0, \quad 0 < d \leq Z$$

$$R_{xx}(d) = \sum_{i=1}^{L-d} x_i\, x_i + d \leq 1, \quad Z < d \leq L-1$$

where the pulse packet is represented by a binary sequence $\{x_1\ x_2\ ...\ x_L\}$ of symbols 0 and 1, in which symbol 1 corresponds to pulse occurrence.

The above constraint is more restrictive than the 'at most one coincidence' requirement, because for all consecutive delay values d = 1, 2, ..., Z, the autocorrelation sequence $R_{xx}(d)$ <u>must</u> equal zero. Therefore, the resulting autocorrelation sequence $R_{xx}(d)$ will exhibit a *zero-correlation zone* of span Z on either side of the main peak of value N at d = 0.

When the duration of a single pulse equals Δ, the zero-correlation zone will correspond to the relative distance ZCD between obstacles equal to ZcΔ/2, where c

is the speed of interrogating pulses (c is the speed of light for electromagnetic pulses).

Consequently, an obstacle-detection system utilizing pulse packets satisfying the modified autocorrelation constraint will have an improved obstacle resolution, because the sidelobes of the autocorrelation function corresponding to a larger obstacle (such as truck) will no longer obscure the main autocorrelation peak associated with a smaller obstacle (such as motorbike) located within the relative distance ZCD from a larger obstacle.

From the modified autocorrelation constraint, it follows that in order to obtain the zero-correlation zone of span Z, the minimum difference between any two pulse positions in the pulse packet cannot be less than (Z+1).

In the case of a pulse packet comprising N pulses with the property 'at most one coincidence', the ratio **R** of the peak autocorrelation value $R_{xx}(0)$ to the *maximum* (unit) autocorrelation sidelobe value is always N. However, it would be extremely advantageous to obtain values of **R** greater than N, thus improving discrimination between large and small obstacles beyond the relative distance ZCD corresponding to the zero-correlation zone. Unfortunately, for a fixed number N of pulses in a packet, the value **R** ≡ N cannot be increased by any deterministic approach.

In accordance with another aspect of the invention, an *average* value of **R** exceeding N is obtained when each pulse of each pulse packet is replaced (substituted) by a *waveform*, drawn at random from a set comprising a finite number of suitably chosen waveforms of finite duration. Preferably, the waveforms should have the same duration and be mutually orthogonal (uncorrelated) to facilitate their discrimination in the receiver. The mechanism of representing a pulse by a randomly selected waveform may be viewed as some form of *random pulse mapping*.

When M orthogonal waveforms are utilized for pulse mapping, a single pulse packet containing N pulses may be represented by as many as M^N *waveform* packets, all packets conveying the same *time* information, yet being different, hence distinguishable in the receiver.

The operation of random pulse mapping retains the time information contained in the pulse-to-pulse intervals, and random pulse mapping itself is equivalent to assigning to each pulse an index selected at random from a set of integers. Those indices may be represented in a physical system in a variety of different ways. Although some suitable formats of modulation, or waveform-for-pulse substitution, are currently regarded as preferable, other attributes of waveforms and wave phenomena (e.g., polarization of electromagnetic waves) can also be employed for 'watermarking' the interrogating pulses.

When no random mapping is applied to a pulse packet comprising N pulses with the property 'at most one coincidence', the ratio **R** of the peak autocorrelation value $R_{xx}(0)$ to the maximum (unit) autocorrelation sidelobe value is just N. However, when M orthogonal waveforms are utilized for random pulse mapping, the unit sidelobe value will, on average, be reduced to 1/M. This effect follows from the fact that the requirement of pulse coincidence 'in time' is now combined with the requirement of equality of indices (additional *coincidence*) assigned to individual pulses. As a result, the average value of the ratio **R** will be increased to NM, and an improved discrimination between large and small obstacles will be extended beyond the relative distance ZCD corresponding to the zero-correlation zone.

Combining the aspects mentioned above, i.e. the modified autocorrelation constraint (leading to an extended zero-correlation zone) and the statistical sidelobe reduction, obtained from random pulse mapping, results in the following set of packet properties:

1. autocorrelation peak N

$$R_{xx}(0) = \sum_{i=1}^{L} x_i^2 = N$$

2. zero-correlation zone

$$R_{xx}(d) = \sum_{i=1}^{L-d} x_i\, x_i + d = 0, \qquad 0 < d \leq Z$$

3. statistical sidelobe reduction via random pulse mapping

$R_{xx}(d) = \sum_{i=1}^{L-d} x_i x_i + d \leq 1/M < 1, \quad Z < d \leq L-1$ where the statistical bound 1/M on the sidelobe values can be satisfied in the 'long run' or 'on average'. Since in practical applications a decision regarding the presence or absence of an obstacle at a given range is based on several thousand pulse packets, the bound 1/M is effectively achievable.

It will be appreciated from the foregoing that it is possible to produce packets of transient signals with advantageous characteristics by (a) using random pulse mapping of the individual transient signals so that they are distinguishable (as distinct from being identical pulses), and/or (b) choosing the timing of the individual transient signals so that they correspond to an underlying binary pulse sequence with good autocorrelation properties.

Random pulse mapping, even if used on its own, provides an excellent resistance to mutual jamming in a multiuser environment. By construction, although each user may employ repeatedly the same transient signal packet, the corresponding sequence of waveforms is assembled in a random manner by each user and is, therefore, statistically unique. The resistance to mutual jamming in a multiuser environment can be further improved by inserting random gaps between individual packets in accordance with the method described above and disclosed in the earlier application. The techniques disclosed in GB-A-2357610 could be used to determine the durations of the gaps.

In some obstacle-detection systems, the peak power of transmitted transient signals is limited and cannot be increased, yet attaining reliable detection coupled with high range resolution is of primary importance. In such cases, a set of orthogonal waveforms used for random pulse coding should contain waveforms which can be compressed in the receiver, and their duration on transmit could be increased up to $(Z+1)\Delta$, where $Z\Delta$ is the shortest interval between primary signals in a packet. The use of 'compressible' waveforms for random pulse mapping will increase the resulting duty factor, by a factor of up to $(Z+1)$, which otherwise may be too low for intended applications.

A broad class of compressible waveforms include transient signals with linear frequency modulation, commonly referred to as LFM, or 'chirp', pulses, and other waveforms known to those skilled in the art.

According to a still further aspect of the invention, a packet with a larger duty factor may be formed by basing the packet on an underlying binary pulse sequence formed by suitably interleaving a primary pulse packet and its time-reversed ('mirror') replica. In such a case, preferably, one set of waveforms will be employed for mapping a primary pulse packet, and another set of waveforms will be used for mapping the 'mirror' replica of the packet. Preferably, the two sets of waveforms are mutually exclusive, i.e., no waveform may belong to both the sets. As a simple example, the waveforms used for the primary packet may have a first frequency, and

those for the mirror replica may have a second frequency. It is preferred, however, for each packet to comprise several different waveforms.

In a preferred embodiment of the invention, some, and preferably all, of these aspects are combined to provide a substantially improved discrimination between multiple small and large obstacles present in a multiuser environment.

DESCRIPTION OF THE DRAWINGS

An arrangement embodying the invention will now be described by way of example with reference to the accompanying drawings, in which:

Fig.1 is a block diagram of a typical obstacle-detection system utilizing short pulses of electromagnetic energy;

Fig.2 depicts a periodic pulse train comprising rectangular pulses of duration T_P and repetition period T_{REP};

Fig.3 is a block diagram of a multichannel pulse-coincidence processor utilized by the obstacle-detection system of Fig.1;

Fig.4 is a block diagram of a simplified analogue multichannel pulse-coincidence correlator;

Fig.5 depicts a pulse packet;

Fig.6(a) depicts the autocorrelation sequence $R_{xx}(d)$ of a binary sequence corresponding to the pulse packet of Fig. 5;

Fig. 6(b) depicts the autocorrelation function $R_{xx}(\tau)$ of the pulse packet of Fig. 5;

Fig.7(a) is an example of a primary pulse packet;

Fig.7(b) depicts another primary pulse packet obtained by time reversal of the packet shown in Fig. 7(a);

Fig. 8 shows the cross-correlation sequence between two binary sequences being mirror images of one another;

Fig.9 depicts the structure of a composite pulse train;

Fig.10(a) is an example of another pulse packet;

Fig.10(b) depicts the autocorrelation sequence of a binary sequence representing the pulse packet of Fig. 10(a);

Fig.11 illustrates the principle of random pulse mapping;

Fig.12 is an example of a pulse packet with increased duty factor;

Fig.13 is a block diagram of an obstacle-detection system incorporating a random pulse mapper arranged to operate in accordance with the present invention;

Fig. 14 is a block diagram of a pulse packet generator of the system of Fig. 13; and

Fig. 15 is a block diagram of a random gap generator for the pulse packet generator of Fig. 14.

DESCRIPTION OF A PREFERRED EMBODIMENT

Fig. 10(a) shows an example of a primary pulse packet which could be used in an obstacle detection system according to the present invention. The packet comprising 11 pulses distributed within 106 positions; the minimum difference between pulse positions in the packet is equal to 6 (positions 78 and 84). Fig. 10(b) depicts the autocorrelation sequence of the packet. The packet satisfies the

modified autocorrelation constraint mentioned above. In accordance with the packet construction, the zero-correlation zone has a span of 5.

Preferably, randomly selected waveforms are substituted for the individual pulses. In the simplest arrangement, the duration of each waveform used for random pulse mapping equals Δ, i.e., the duration of each primary pulse.

Fig. 11 illustrates a primary pulse packet (the same as already shown in Fig.10(a)) and a resulting waveform packet obtained by selecting one of four available waveforms, w1(t), w2(t), w3(t) and w4(t), indexed by numbers 1, 2, 3 and 4. In this case, the waveforms are significantly longer than the pulses of the basic pulse packet. For illustrative purposes, it is assumed that a random mechanism employed for waveform selection has produced the following sequence of numbers: 1, 4, 1, 2, 3, 1, 3, 3, 4, 2, 4. As seen, the primary pulse packet and the resulting waveform packet, being aligned in time, both contain the same time information.

In order to improve the duty factor, the basic pulse packet can be modified. As an illustrative example, Fig. 12(a) shows the primary pulse packet of Fig. 10(a), Fig. 12(b) shows a 'mirror' replica of the packet, and Fig. 12(c) depicts a pulse packet resulting from interleaving the primary packet with a time-shifted 'mirror' replica of the packet. Again, in practice, waveforms can be used in place of the discrete pulses. As indicated above, it is important for at least a substantial number of the

transient signals of each packet to be distinguishable from those of the other packet (and desirable for them to be distinguishable from each other).

The duty factor of a pulse packet can be increased even more, if a supplementary packet (or packets) with the property 'at most one coincidence' is inserted into the combination of a primary packet and its 'mirror' replica. However, more waveforms will be required for random mapping of pulses belonging to all interleaved packets.

Fig. 13 is a block diagram of an obstacle-detection system incorporating a random pulse mapper RPM and arranged to operate in accordance with the present invention. The system also comprises a pulse packet generator PPG, driven by a clock generator CKG, an antenna driver ADR coupled to a suitable transmit antenna TA, a serial-in-parallel-out shift register SIPO, a suitable receive antenna RA connected to an input amplifier IAM, a bank of M matched filters, MF1, MF2, ... , MFM, and a plurality of range-cell processors RCPs. As will be explained later, the system may also incorporate an oscillator OSC supplying a sinusoidal signal at a suitable carrier frequency to both ADR and IAM.

The pulse packet generator PPG supplies repeatedly pulses to the random pulse mapper RPM, and more specifically to: input PP of a multiplexer MPX, load input LI of a storage register SRG, and input PP of a pulse identifier PID. Each pulse supplied by the generator PPG triggers one out of M waveforms generators, WG1, WG2, ... , WGM, in response to the value of a number generated by a random index

generator RIG. This value is loaded via input IN to a storage shift register SRG prior to the time instant of each pulse occurrence.

Preferably, waveforms w1(t), w2(t), ... , wM(t) to be supplied by the M waveforms generators WG1, WG2, ... , WGM should be mutually orthogonal to facilitate the discrimination of signals reflected back by obstacles. In particular, a suitable set of waveforms can be produced by using short segments of sinewaves, each with substantially different frequency. In this specific case, the bank of matched filters will comprise band-pass filters, each with a centre frequency equal to the frequency of a respective sinewave, and with the bandwidth inversely proportional to the duration of the sinewave segment.

Short segments of sinewaves can readily be generated by suitably modified ringing or blocking oscillators. Another method, disclosed in US-A- 3,612,899 (incorporated herein by reference), enables forming very narrow pulses of electromagnetic energy directly at microwave carrier frequency.

The value of a random index ID held at input OS of multiplexer MPX determines a specific path for each pulse to trigger the respective waveform generator corresponding to that index value. For example, when the index value is 2, waveform generator WG2 will be triggered to produce a suitable waveform w2(t), which (via a summing amplifier SAM and driver ADR coupled to antenna TA) will be sent as an interrogating signal towards obstacles.

When waveforms produced by the waveform generators WG1, WG2, ... , WGM, are generated at a suitable carrier frequency (or frequencies), they can (after suitable conditioning and, if required, amplification in driver ADR) be sent directly by antenna TA as interrogating signals. However, when the waveform generators, WG1, WG2, ..., WGM, can supply only baseband versions of waveforms, some form of 'upconverting' (modulation) will be required prior to delivering those waveforms to the transmit antenna TA. In such a case, the antenna driver ADR will incorporate a suitable modulator utilizing a sinusoidal reference signal at a carrier frequency, provided by the auxiliary oscillator OSC, and applied via input CF to the driver ADR.

For each pulse provided by generator PPG, the pulse identifier PID combines a random index ID, assigned to that pulse (by the random index generator RIG), with timing information (supplied via input PP) regarding the pulse occurrence. The resulting combination may be represented by a binary word; for example, the most significant bit (MSB) equal 1 may mark the pulse occurrence, whereas the remaining bits may represent the value of the random index ID assigned to that pulse.

Binary words thus created are applied via input DI to register SIPO; the words are shifted into register SIPO at the time instants determined by clock pulses appearing at input CP of the register SIPO. As a result, each pulse supplied by the pulse

packet generator PPG is represented by a respective binary word in a unique way: the time of pulse occurrence has been imparted on a corresponding time slot (i.e. clock period) by setting MSB to 1, whereas the random index ID has been used to determine the values of the remaining bits of the binary word.

The register SIPO acts as a digital discrete-time delay line with total delay (expressed in units of clock period) equal to the number of used storage cells, i.e. W in the arrangement shown in Fig. 13. Consequently, the register SIPO stores and retains the continually updated information regarding all primary pulses generated and mapped during the last W clock periods. This information is made available at W parallel outputs of the register SIPO; either all or only selected register SIPO outputs are connected to respective range-cell processors RCPs. For illustrative purposes, Fig. 13 shows output K of the register SIPO connected to a corresponding processor RCP.

A signal reflected back by an obstacle and received via the receive antenna RA is applied to the input amplifier IAM. When the matched filters, MF1, MF2, ..., MFM, are capable of processing only the baseband versions of waveforms w1(t), w2(t), ... , wM(t), some means for 'downconverting' (demodulation) will have to be incorporated into the amplifier IAM. Accordingly, a sinusoidal reference signal at a suitable frequency can be provided by the auxiliary oscillator OSC coupled to input CF of the amplifier IAM.

The bank of M matched filters, MF1, MF2, ..., MFM, is constructed to operate as follows. When any of the utilized waveforms, w1(t), w2(t), ... , wM(t), is applied to the common input of the matched filters, only the filter matched to this particular waveform will produce an unequivocal response; the residual responses of all remaining matched filters will be negligible. This specific property of the bank of matched filters is exploited to reliably recover from a received signal the value of a random index ID, assigned to each underlying pulse, during random pulse mapping.

The functions and operations performed by each range-cell processor RCP can be summarised as follows:

1. Each binary word supplied by a respective output of register SIPO is decomposed in a word decoder WDR into a signal PP indicating the pulse occurrence and a random index ID assigned to that pulse by the random index generator RIG during random pulse mapping.

2. The signal PP is applied to sampling input SS of a sampling circuit SCT, whereas the random index ID selects, via input IS of a channel selector CHS, the output of a matched filter corresponding to that index. Depending on the implementation, each matched filter may provide at its output either a multilevel (e.g., analogue) signal, indicative of the strength of a received waveform, or just a binary signal, indicative of whether or not the strength of a received waveform is substantially greater than that of background noise and/or interference.

3. The thus-selected output of a respective matched filter is applied to the sampling circuit SCT and then sampled at the time instant coincident with the signal PP appearing at input SS. When a matched filter produces at its output a binary signal, the sampling circuit SCT can be reduced to a simple logic gate. It will, incidentally, be noted that the duration of the filter output will be dependent on the received waveform and the filter characteristics. The use of relatively long waveforms is acceptable if the characteristics are such that the filter output has a suitable duration.

4. The output of SCT is fed to an integrator INT which may be of 'integrate-and-dump' type, or 'running-average' ('moving-window') type. When the sampling circuit SCT is replaced by a logic gate, a suitably configured pulse counter can also perform the required integration.

5. The resultant level reached by the integrator INT is compared to a predetermined decision threshold DT in a comparator CMP. If the decision threshold DT has been exceeded, the presence of an obstacle will be declared in the range cell corresponding to the delay of the register SIPO output connected to the respective range-cell processor RCP.

As seen, the main function performed jointly by the processor RCP and the bank of matched filters is that of a waveform 'de-mapper' combined with that of a conventional correlation receiver. As a result, the decision outputs of all processors

RCPs provide a comprehensive picture of potential obstacles present in range cells constituting the field of view (FOV) of an obstacle-detection system. This 'snapshot' information can be utilized by a suitable obstacle-tracking system to produce warning signals to alert the driver, and also other signals used to initiate the operation of intended pre-crash actuators, such as air bags, brakes, etc.

Fig. 14 is a block diagram of one possible structure of the pulse packet generator PPG. The generator comprises a sequential state module SSM, a state decoder STD, a random gap generator RGG and a clock generator CKG.

During the system operation, the sequential state module SSM changes its state successively at the time instants determined by clock pulses CLK supplied by the clock generator CKG. The total number NS of distinct states of the sequential state module SSM should be at least equal to the span L_{max} of the longest primary pulse packet used by the system; hence

$$NS = 2^K \geq L_{max}$$

where K is the number of flip-flops utilized by the sequential state module SSM. Redundant states of the sequential state module SSM may be employed for generating a regular gap, and the remaining states, if any, should be eliminated. If the number ($NS - L_{max}$) of redundant states is too small to generate a complete regular gap, the remaining part of the gap, or even the whole regular gap, can additionally be supplied by the random gap generator RGG.

The sequential state module SSM is arranged to operate cyclically, each cycle comprising NU distinct states selected in some convenient manner from the total number $NS = 2^K$ of available distinct states. Among those NU distinct states, there are N predetermined states representing the positions of pulses in each pulse packet to be generated.

The function of the sequential state module SSM can be implemented by a conventional binary counter, by a shift register with a suitable feedback or by a similar sequential state machine well known to those skilled in the art.

The state decoder STD is driven by a K-bit output of the sequential state module SSM. The state decoder STD has two outputs: one output supplies a composite pulse train CPT, whereas the other produces an end-of-packet EOP pulse. For example, an EOP pulse may coincide with the trailing pulse of every pulse packet. The EOP pulse is utilized to initiate operations performed by the random gap generator RGG.

All functions of the state decoder STD can be implemented by a combinational logic or by a suitably programmed read-only memory.

The random gap generator RGG appends a random gap to the trailing pulse of every primary pulse packet being produced. Each cycle of the repetitive operation of the random gap generator RGG is initiated by an EOP pulse supplied by the state decoder STD. The random gap is inserted by inhibiting a random number of clock pulses

provided by the clock generator CKG. The output CRG of the random gap generator RGG supplies a sequence of clock pulses in which a random number of consecutive pulses are missing. As a result, the operation of the sequential state module SSM is suspended during a random time interval equal to the duration of the random gap. Preferably, the duration of each random gap is uniformly distributed, and the random gaps are formed independently of each other. If required, the random gap generator RGG can also supply a fraction of a regular gap or even a complete regular gap.

Fig. 15 is a block diagram of a random gap generator RGG. The random gap generator RGG comprises a random pulse counter RPC, a two-input multiplexer MUX, a flip-flop FF and an AND logic gate ALG. The random gap generator RGG utilizes a random pulse train RPT with a sufficiently high pulse rate. A suitable device for providing the random pulse train RPT will be evident to the skilled man.

The random pulse counter RPC capacity is determined by the assumed largest value of a random gap. The random pulse counter RPC capacity should be small compared to the total number of random pulses supplied by the random pulse train RPT during one cycle of the sequential state module SSM. As a result, the random pulse counter RPC will overflow a large number of times during each sequential state module SSM cycle, and only the fractional part of the total number of applied random pulses will be retained in the random pulse counter RPC at the time instants coinciding with EOP pulses. This fractional part is distributed uniformly over all counter states, irrespective of the underlying statistics of random pulses occurring in a random pulse train RPT.

The multiplexer MUX operates as follows: when the binary source select input SS=1, the random pulse counter RPC receives a random pulse train RPT, and when SS=0, the random pulse counter RPC receives clock pulses CLK.

Prior to the occurrence of an end-of-packet EOP pulse, the flip-flop FF is in state '1' (hence, also SS=1), clock pulses appear at the output of the AND gate ALG, and the random pulse train RPT is applied to the random pulse counter RPC via the multiplexer MUX. As soon as an EOP pulse is applied to the reset input RI of the flip-flop FF, the flip-flop FF will assume state '0' and no clock pulses CLK will appear at the output of the AND gate ALG. Because the flip-flop FF also drives the SS input of the multiplexer MUX, now SS=0 and clock pulses CLK are applied to the random pulse counter RPC via the multiplexer MUX. The number of clock pulses required to bring the random pulse counter RPC from its initial random state to the overflow state is a random and uniformly distributed number.

As soon as the overflow occurs, a suitable signal is applied to the set input SI of the flip-flop FF, and the flip-flop FF assumes state '1'. Because now SS=1, the random pulse counter RPC will resume counting (with overflow) random pulses in the random pulse train RPT, and clock pulses CLK will appear again at the output of the AND gate ALG.

The above procedure results in inserting a random gap into a sequence of clock pulses appearing at the output of the AND gate ALG. The duration of the random gap is equal to the random number of clock pulses CLK required to make the random pulse counter RPC overflow. Therefore, the duration of the random gate has a uniform distribution.

The specific overflow condition due to counting clock pulses CLK forces the random pulse counter RPC to assume an initial state '0', before the random pulse counter RPC restarts counting random pulses in the random pulse train RPT . Because of a large number of overflows resulting from counting random pulses, the random states of the random pulse counter RPC are assumed to be statistically independent at the time instants determined by the occurrence of end-of-packet EOP pulses.

The arrangement described above repeatedly produces pulse packets of finite length, and a mapping process is used to substitute waveforms for the individual pulses. Various modifications are possible.

For example, the waveforms could be produced directly, at the required timings, without needing to generate pulses first. (It would nevertheless be possible to deduce for each packet a *nominal* binary pulse train, and its autocorrelation function, corresponding to the timing of the waveform generation.)

Instead of using distinguishable waveforms of preferably finite, limited duration, the transient signals could be formed by respective sub-sequences of pulses, distinguishable by the timing of the pulses within each sub-sequence.

The obstacle detection system of Fig. 13 may be mounted on a movable platform (such as a vehicle or vessel), or on a stationary platform to detect the approach of a movable object. The system can be a collision-warning system arranged to generate a warning signal in response to detection of an object. Additionally or alternatively, the system may be a ranging aid having means, such as the arrangement of Fig. 3 or Fig. 4, for detecting the range of an obstacle and for generating a signal indicative of the range.

It is desirable for the packets of transient signals generated by multiple systems to satisfy the cross-correlation constraint mentioned above, and in particular for the cross-correlation functions to have values which are all small compared with the maximum values of each autocorrelation function. Furthermore, because of the desirability for each system to have the same structure, it is preferable for these conditions to apply to the cross-correlation properties of different packets produced by an individual system. This, however, can be achieved by virtue of the techniques described above, particularly the provision of pulse mapping, random intervals between packets and timing sequences selected to have good correlation properties.

It will be clear from the above description that references to the form of transient signals (e.g. single pulses or waveforms) are intended to relate to the baseband form of those signals; clearly the detailed structure of transmitted waveforms may differ if the transient signals are used for carrier modulation for transmission.

The term "random" is intended herein to include, without limitation, not only purely random, non-deterministically generated signals, but also pseudo-random and/or deterministic signals such as the output of a shift register arrangement provided with a feedback circuit as used in the prior art to generate pseudo-random binary signals, and chaotic signals.

The embodiments described herein can be implemented using dedicated hardware, incorporating for example digital signal processors, or using suitably-programmed general-purpose computers.

The foregoing description of preferred embodiments of the invention has been presented for the purpose of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. In light of the foregoing description, it is evident that many alterations, modifications, and variations will enable those skilled in the art to utilize the invention in various embodiments suited to the particular use contemplated.

CLAIMS:

1. A method of generating packets of transient signals, the signals within each signal packet being generated at timings corresponding to a binary pulse sequence having an autocorrelation function which, for all non-zero shifts, has a value which is substantially smaller than the maximum value at zero shift;

the method involving ensuring that the times of occurrence of the signals within a packet are such that the minimum gap between adjacent pulses in the corresponding binary pulse sequence exceeds a predetermined value, whereby the autocorrelation function of the binary pulse sequence exhibits a zero value for consecutive relative shifts which do not exceed a predetermined limit.

2. A method as claimed in claim 1, wherein each transient signal is a single pulse.

3. A method as claimed in claim 1, wherein each transient signal is a finite pulse train.

4. A method as claimed in claim 1, wherein each transient signal is a waveform with predetermined characteristics.

5. A method of generating packets of transient signals, the signals within each signal packet being generated at timings corresponding to a binary pulse

sequence having an autocorrelation function which, for all non-zero shifts, has a value which is substantially smaller than the maximum value at zero shift;

wherein each transient signal is a waveform with predetermined characteristics.

6. A method as claimed in claim 4 or 5, including the step of randomly selecting the transient waveform from a set of waveforms of different characteristics.

7. A method as claimed in claim 6, in which each transient waveform of a packet thereof is individually randomly selected.

8. A method as claimed in claim 6 or 7, in which the waveforms of said set are substantially mutually orthogonal.

9. A method as claimed in any preceding claim, in which a transient signal packet includes signals at timings corresponding to a composite sequence including a first binary pulse sequence interleaved with a second binary pulse sequence which is a time-reversed replica of the first binary pulse sequence, at least a substantial number of the transient signals corresponding to each binary pulse sequence being distinguishable from those corresponding to the other binary pulse sequence.

10. A method of generating packets of transient signals, the signals within each packet being generated at timings corresponding to a binary pulse sequence having an autocorrelation function which, for all non-zero shifts, has a value which is substantially smaller than the maximum value at zero shift;

wherein at least one transient signal packet is based on a composite sequence including a first binary pulse sequence interleaved with a second binary pulse sequence which is a time-reversed replica of the first binary pulse sequence, at least a substantial number of the transient signals corresponding to each binary pulse sequence being distinguishable from those corresponding to the other binary pulse sequence.

11. Apparatus for generating packets of transient signals, the apparatus being arranged to operate in accordance with a method as claimed in any preceding claim.

12. Obstacle detection apparatus for use in a multi-user environment comprising apparatus as claimed in claim 11 for generating packets of transient signals, means for transmitting said transient signals, receiving means for receiving reflections of the transmitted transient signals, and processing means for correlating the transmitted signals with the received signals in order to detect the presence or absence of obstacles.

13. Obstacle detection apparatus as claimed in claim 12, including means for providing a signal indicative of the range of a detected object.

14. Obstacle detection apparatus as claimed in claim 12 or 13 for use in a vehicle or vessel to detect potential collisions.

15. A collision-warning system for a vehicle or vessel, the system comprising an obstacle detection apparatus as claimed in claim 14 and means for generating a warning signal in response to obstacle detection.

16. A ranging aid for a vehicle or vessel, the system comprising an obstacle detection apparatus as claimed in claim 14 and means for generating a signal indicative of the range of a detected obstacle.

ABSTRACT

The signals within a packet of transient signals are generated at timings corresponding to a binary pulse sequence having an autocorrelation function which, for all non-zero shifts, has a value which is substantially smaller than the maximum value at zero shift. The times of occurrence of the signals within a packet are such that the minimum gap between adjacent pulses in the corresponding binary pulse sequence exceeds a predetermined value, whereby the autocorrelation function of the binary pulse sequence exhibits a zero value for consecutive relative shifts which do not exceed a predetermined limit. Each transient signal may be a randomly-selected waveform with predetermined characteristics. At least one packet may be based on a composite sequence including a first binary pulse sequence interleaved with a second binary pulse sequence which is a time-reversed replica of the first binary pulse sequence, at least a substantial number of the transient signals corresponding to each binary pulse sequence being distinguishable from those corresponding to the other binary pulse sequence.

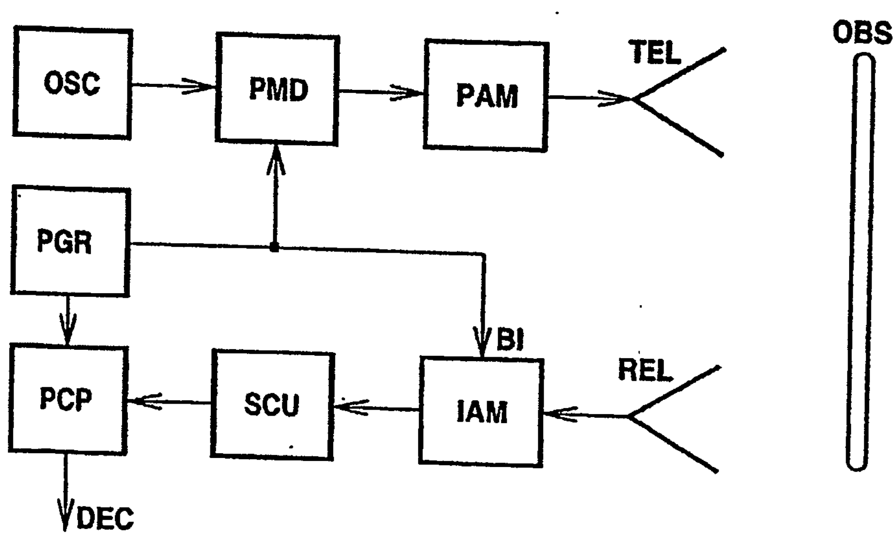
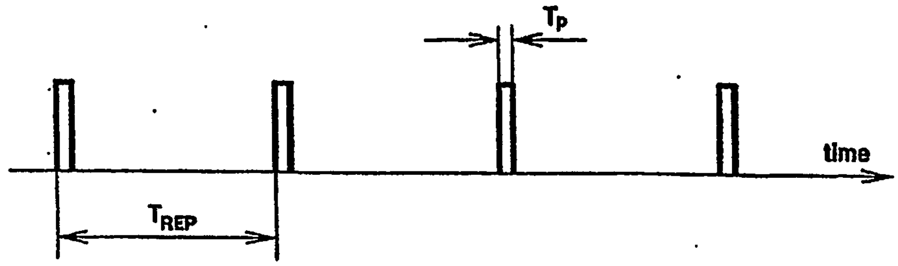
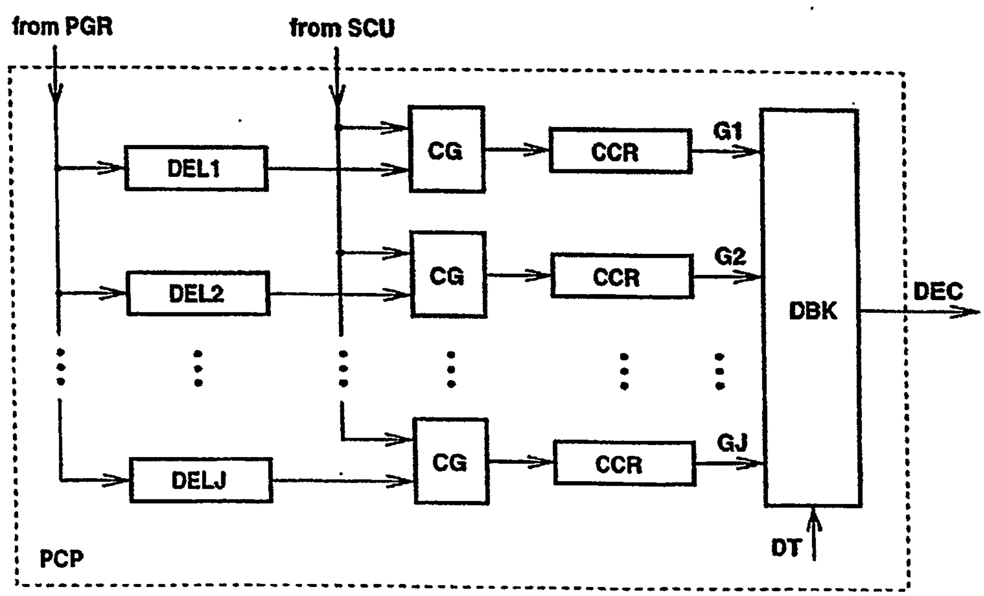


FIG. 1



T_P
time
T_{REP}

FIG. 2



from PGR
from SCU
DEL1
DEL2
DELJ
CG
CG
CG
CCR
CCR
CCR
G1
G2
GJ
DBK
DEC
DT
PCP

FIG. 3

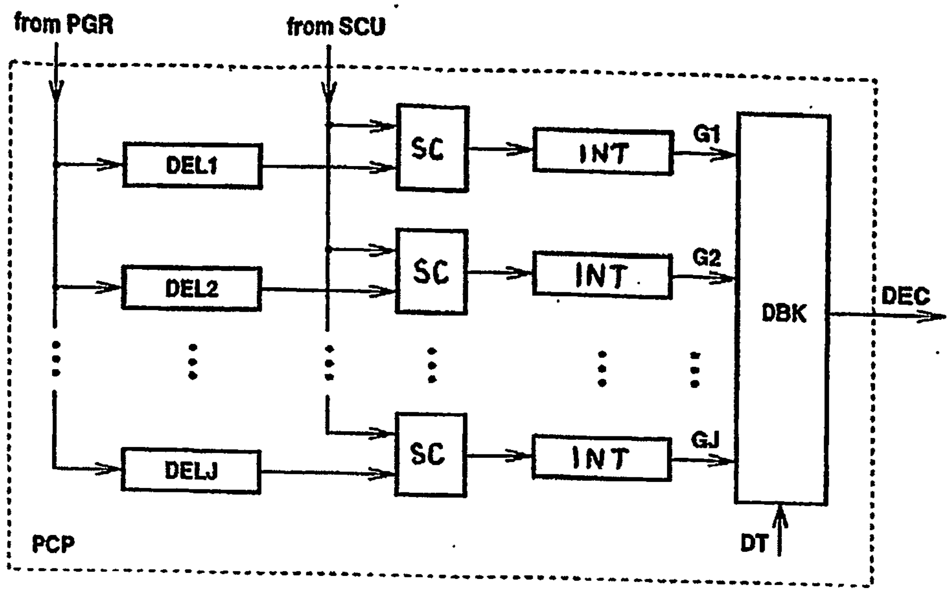

from PGR
from SCU
DEL1
DEL2
DELJ
SC
SC
SC
INT
INT
INT
G1
G2
GJ
DBK
DEC
DT
PCP

FIG. 4

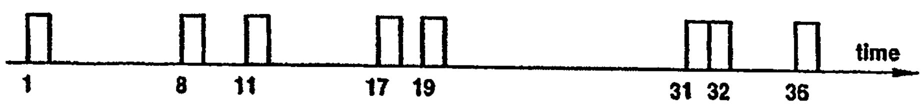

1
8
11
17
19
31
32
36
time

FIG. 5

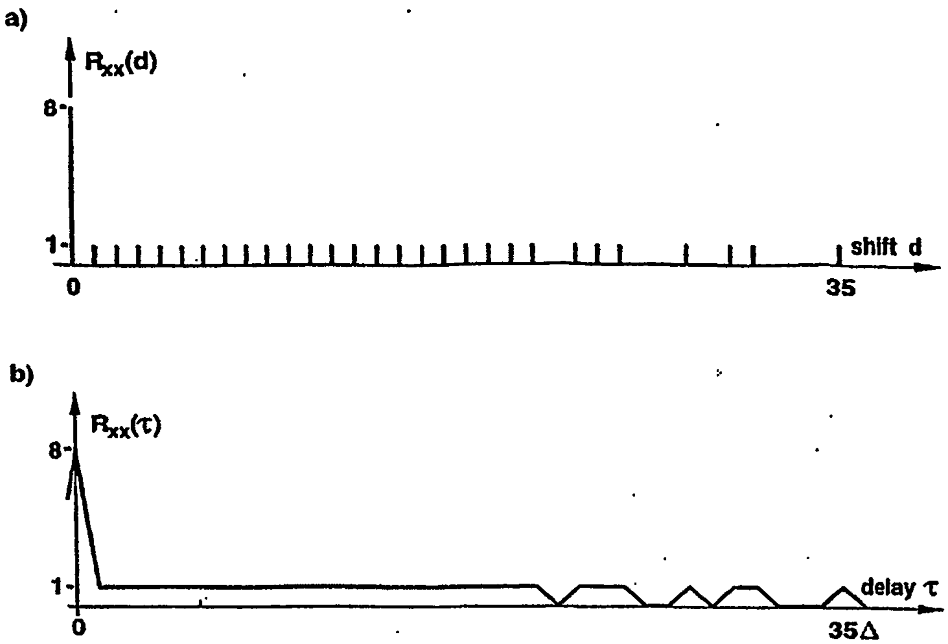


FIG. 6

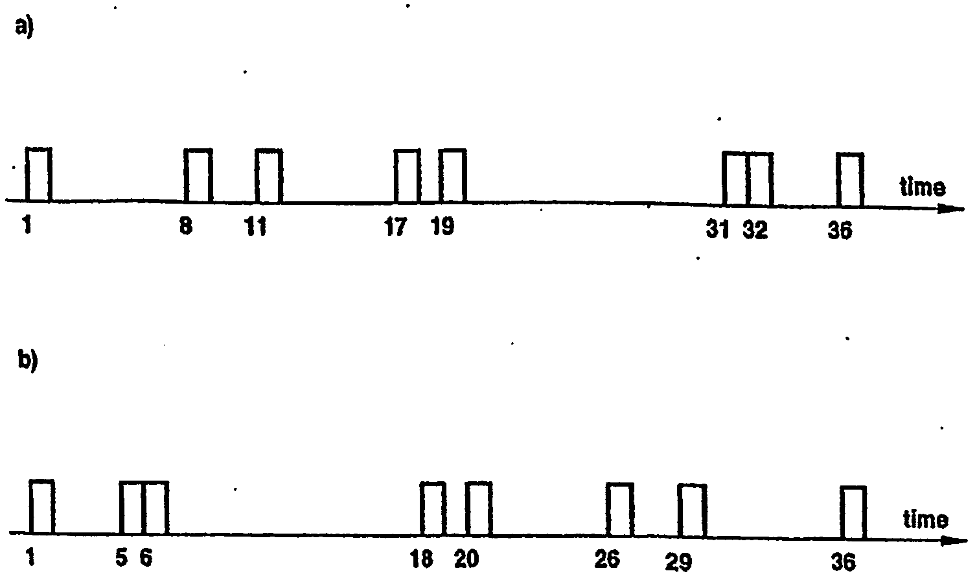

a)
time
1
8
11
17
19
31
32
36
b)
time
1
5
6
18
20
26
29
36

FIG. 7

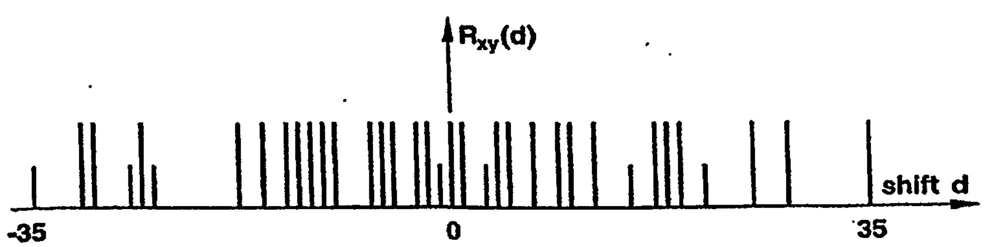

Rxy(d)
shift d
-35
0
35

FIG. 8

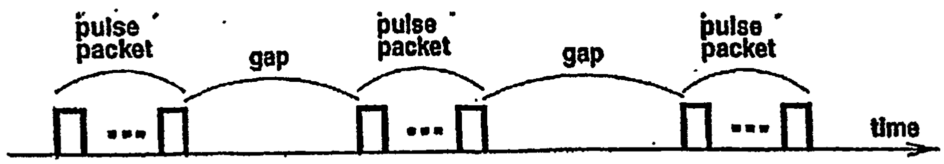

pulse packet
gap
pulse packet
gap
pulse packet
time

FIG. 9

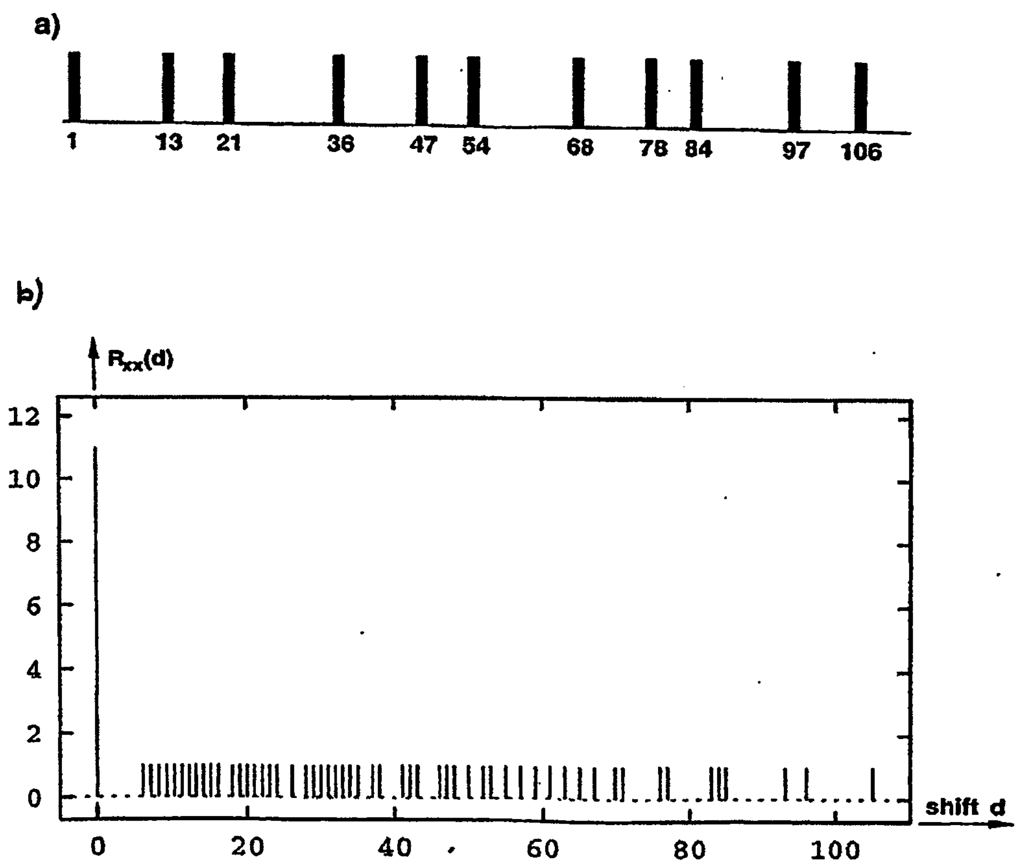

a)
1
13
21
36
47
54
68
78
84
97
106
b)
$R_{xx}(d)$
12
10
8
6
4
2
0
0
20
40
60
80
100
shift d

FIG. 10

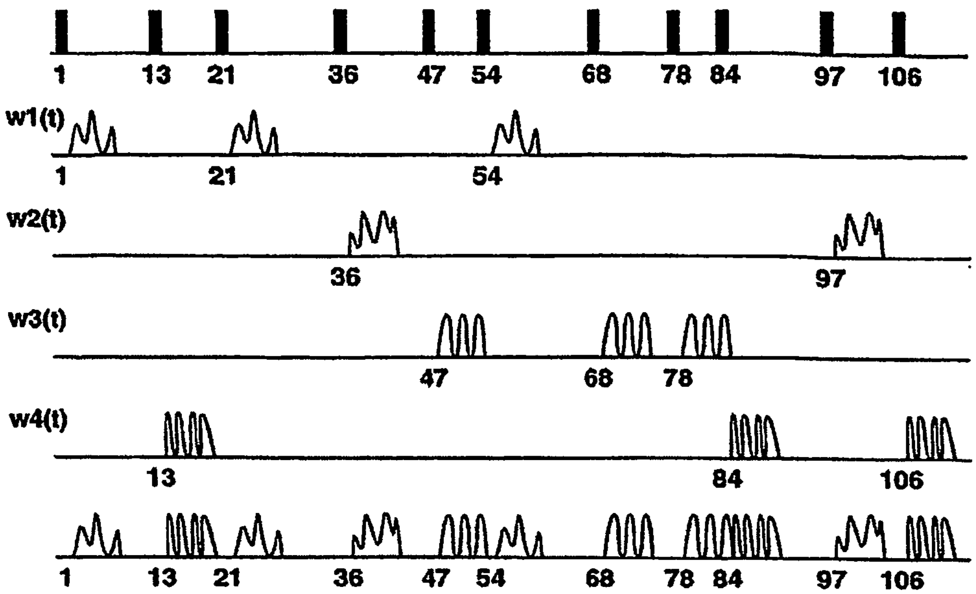

1
13
21
36
47
54
68
78
84
97
106
w1(t)
1
21
54
w2(t)
36
97
w3(t)
47
68
78
w4(t)
13
84
106
1
13
21
36
47
54
68
78
84
97
106

FIG. 11

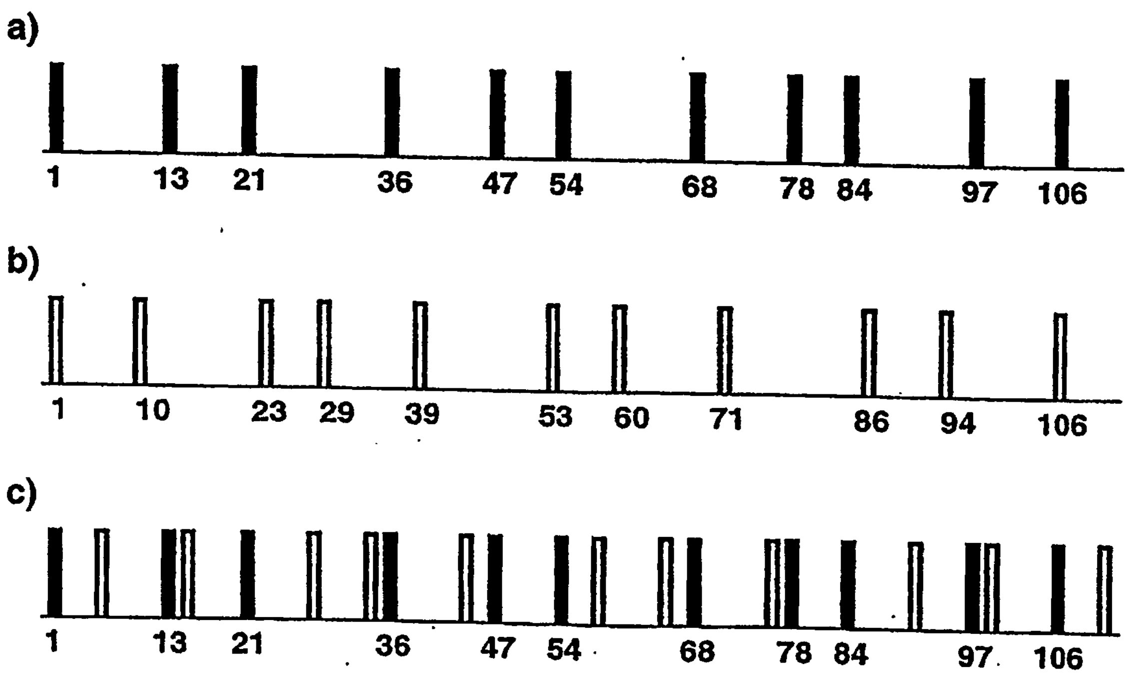

a)
1
13
21
36
47
54
68
78
84
97
106
b)
1
10
23
29
39
53
60
71
86
94
106
c)
1
13
21
36
47
54
68
78
84
97
106

FIG. 12

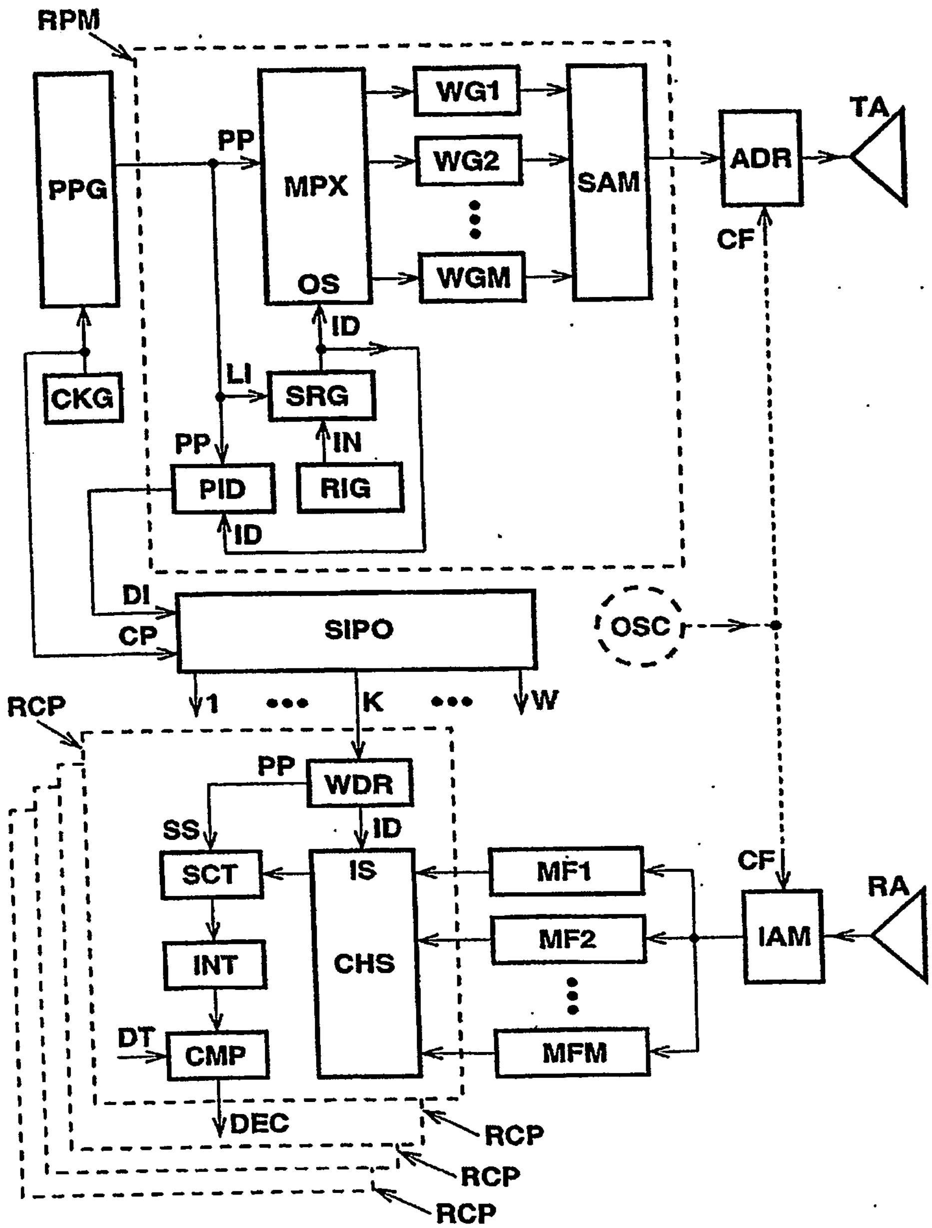

RPM
PPG
PP
MPX
WG1
WG2
WGM
SAM
ADR
TA
OS
ID
CF
CKG
LI
SRG
PP
IN
PID
RIG
ID
DI
SIPO
OSC
CP
1
K
W
RCP
PP
WDR
SS
ID
SCT
IS
MF1
CF
RA
CHS
MF2
IAM
INT
DT
CMP
MFM
DEC
RCP
RCP
RCP

FIG. 13

FIG. 14

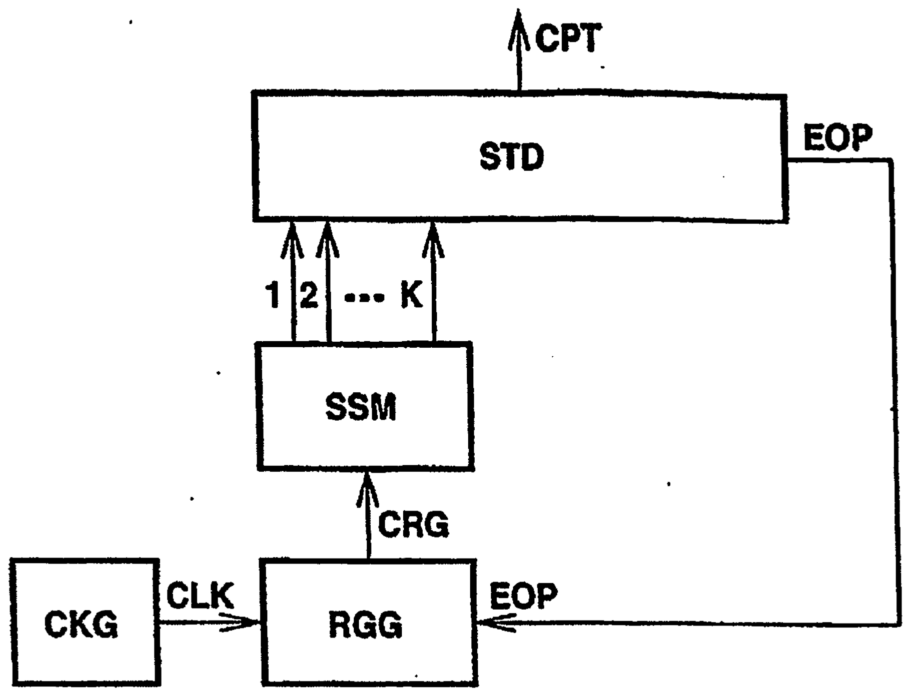
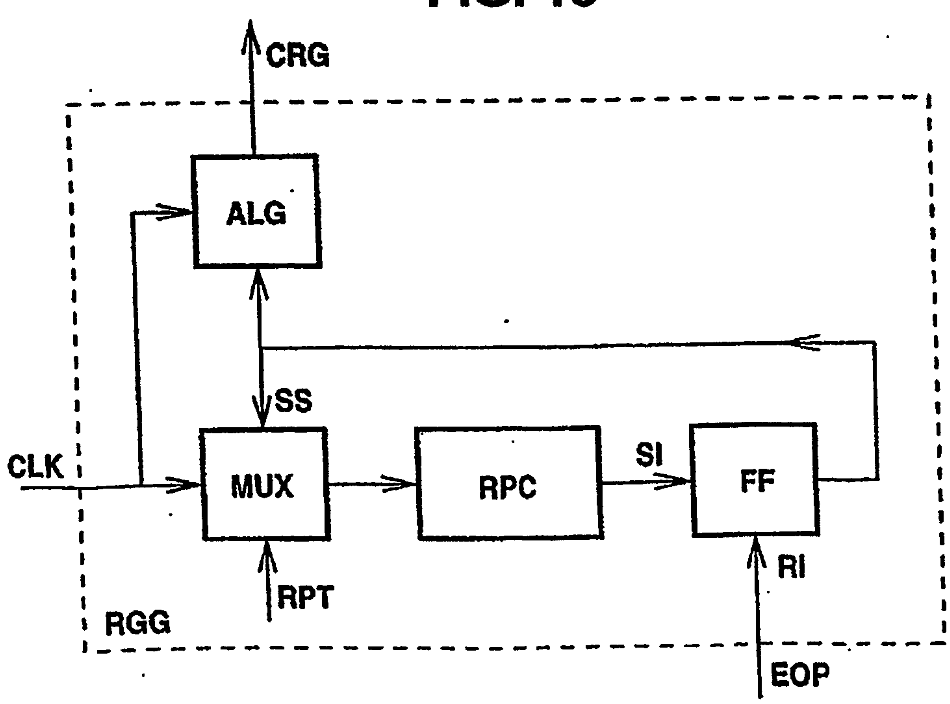

CPT
STD
EOP
1
2
••• K
SSM
CRG
CKG
CLK
RGG
EOP

FIG. 15


CRG
ALG
SS
CLK
MUX
RPC
SI
FF
RPT
RI
RGG
EOP

Antrag auf Erteilung eines europäischen Patents / Request for grant of a European patent / Requête en délivrance d'un brevet européen

Bestätigung einer bereits durch Telefax eingereichten Anmeldung / Confirmation of an application already filed by facsimile / Confirmation d'une demande déjà déposée par téléfax — ☐ Ja / Yes / Oui

Wenn ja, Datum der Übermittlung des Telefax und Name der Einreichungsbehörde / If yes, facsimile date and name of the authority with which the documents were filed / Si oui, date d'envoi du téléfax et nom de l'autorité de dépôt — Datum / Date — Behörde / Authority / Autorité

IPERIONE A

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Anmeldenummer / Application No. / N° de la demande	MKEY	1	03254298.7
Tag des Eingangs (Regel 24(2)) / Date of receipt (Rule 24(2)) / Date de réception (règle 24(2))	DREC	2	07 JUL 2003
Tag des Eingangs beim EPA (Regel 24(4)) / Date of receipt at EPO (Rule 24(4)) / Date de réception à l'OEB (règle 24(4))	RENA	3	EPO DG 1 25. 07. 2003
Anmeldetag / Date of filing / Date de dépôt		4	

Tabulatoren-Positionen / Tabulation marks / Arrêts de tabulation

Es wird die Erteilung eines europäischen Patents und gemäß Artikel 94 die Prüfung der Anmeldung beantragt / Grant of a European patent, and examination of the application under Article 94, are hereby requested / Il est demandé la délivrance d'un brevet européen et, conformément à l'article 94, l'examen de la demande	EXAM 4	5	☒ *Prüfungsantrag in einer zugelassenen Nichtamtssprache (siehe Merkblatt II, 5): / Request for examination in an admissible non-EPO language (see Notes II,5): / Requête en examen dans une langue non officielle autorisée (voir notice II,5):*
Zeichen des Anmelders oder Vertreters (max. 15 Positionen) / Applicant's or representative's reference (maximum 15 spaces) / Référence du demandeur ou du mandataire (max. 15 caractères ou espaces)	AREF	6	J00045529EP
Anmelder / Applicant / Demandeur Name / Nom		7	MITSUBISHI ELECTRIC INFORMATION TECHNOLOGY CENTRE EUROPE B.V.
Anschrift / Address / Adresse	APPR 01 # 3 0 6 0 6 7 3 5 # DEST #	8	20 Frederick Sanger Road, The Surrey Research Park, Guildford, Surrey, GU2 7YD, U.K.
Zustellanschrift / Address for correspondence / Adresse pour la correspondance	PADR	9	
Staat des Wohnsitzes oder Sitzes / State of residence or of principal place of business / Etat du domicile ou du siège		10	United Kingdom
Staatsangehörigkeit / Nationality / Nationalité		11	Dutch
Telefon / Telephone / Téléphone		12	
Telex / Télex — Telefax / Fax / Téléfax		13	
Weitere(r) Anmelder auf Zusatzblatt / Additional applicant(s) on additional sheet / Autre(s) demandeur(s) sur feuille additionnelle		14	☒
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Geschäftsanschrift / Address of place of business / Adresse professionnelle		16	RGC Jenkins & Co 26 Caxton Street London SW1H 0RJ United Kingdom
Telefon / Telephone / Téléphone		17	+44 (0)20 7931 7141
Telex / Télex — Telefax / Fax / Téléfax		18	+44 (0)20 7222 4660
Weitere(r) Vertreter auf Zusatzblatt / Additional representative(s) on additional sheet / Autre(s) mandataire(s) sur feuille additionnelle		19	☒

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J00045529EP

Raum für Zeichen des Anmelders / Space for applicant's reference / Espace réservé à la référence du demandeur

Vollmacht / Authorisation / Pouvoir

ist beigefügt / is enclosed / joint	20	☐
ist registriert unter Nummer / has been registered under No. / a été enregistré sous le n° — GENA	21	Nummer / Number / Numéro

Erfinder / Inventor / Inventeur — INVT 20 # #

Anmelder ist (sind) alleinige(r) Erfinder / The applicant(s) is (are) the sole inventor(s) / Le(s) demandeur(s) est (sont) le (les) seul(s) inventeur(s)	22	☐
Erfindernennung in gesondertem Schriftstück / Designation of inventor attached / Voir la désignation de l'inventeur ci-jointe	23	☒

Bezeichnung der Erfindung / Title of invention / Titre de l'invention — 24

TIDE	TIEN	TIFR

GENERATION OF PACKETS OF WAVEFORMS

Prioritätserklärung / Declaration of priority / Déclaration de priorité — PRIO — 25

	Staat / State / Etat	Anmeldetag / Date of filing / Date de dépôt	Aktenzeichen / Application No. / N° de la demande
01 # . . # . . . . #	1		
02 # . . # . . . . #	2		
03 # . . # . . . . #	3		
04 # . . # . . . . #	4		

Weitere Prioritätserklärung(en) auf Zusatzblatt / Additional declaration(s) of priority on additional sheet / Autre(s) déclaration(s) de priorité sur feuille additionnelle ☐

25a ☐ Es wird hiermit erklärt, daß die Anmeldung eine vollständige Übersetzung der früheren Anmeldung ist (Regel 38(5)) / It is hereby declared that the application is a complete translation of the previous application (Rule 38(5)) / Il est déclaré par la présente que la demande est une traduction intégrale de la demande antérieure (règle 38(5)) — PRIO 6

26 ☐

Biologisches Material

Die Erfindung bezieht sich auf bzw. verwendet biologisches Material, das nach Regel 28 hinterlegt worden ist.

Biological material

The invention relates to and/or uses biological material deposited under Rule 28.

Matière biologique

L'invention concerne et/ou utilise de la matière biologique, déposée conformément à la règle 28.

BIOM 1 # | | | | | | | | #

27 Die Angaben nach Regel 28(1)c) (falls noch nicht bekannt, die Hinterlegungsstelle und das (die) Bezugszeichen [Nummer, Symbole usw.] des Hinterlegers) sind in den technischen Anmeldungsunterlagen enthalten auf / The particulars referred to in Rule 28(1)(c) (if not yet known, the depository institution and the identification reference(s) [number, symbols etc.] of the depositor) are given in the technical documents in the application on / Les indications visées à la règle 28(1)c) (si pas encore connues, l'autorité de dépôt et la (les) référence(s) d'identification [numéro ou symboles etc.] du déposant) figurent dans les pièces techniques de la demande à la /aux

Seite(n) / page(s)	Zeile(n) / line(s) / ligne(s)

27a ☐ werden später mitgeteilt / will be submitted later /seront communiquées ultérieurement

27b ☐ Die Empfangsbescheinigung(en) der Hinterlegungsstelle ist (sind) beigefügt / The receipt(s) of deposit issued by the depositary institution is (are) enclosed / Le(s) récépissé(s) de dépôt délivré(s) par l'autorité de dépôt est (sont) joint(s)

27c ☐ wird (werden) nachgereicht / will be filed later /sera (seront) produit(s) ultérieurement

J00045529EP

Raum für Zeichen des Anmelders / Space for applicant's reference / Espace réservé à la référence du demandeur

28 Falls das biologische Material nicht vom Anmelder, sondern von einem Dritten hinterlegt wurde: / Where the biological material has been deposited by a person other than the applicant: / Lorsque la matière biologique a été déposée par une personne autre que le demandeur:

Name und Anschrift des Hinterlegers / Name and address of depositor / Nom et adresse du déposant :

Ermächtigung nach Regel 28(1)d) / Authorisation under Rule 28(1)(d) / L'autorisation en vertu de la règle 28(1)d)

- **28a** ☐ ist beigefügt / is enclosed / est jointe
- **28b** ☐ wird nachgereicht / will be filed later / sera produite ultérieurement

29 ☐ Verzicht auf die Verpflichtung des Antragstellers nach Regel 28(3) in gesondertem Schriftstück / Waiver of the right to an undertaking from the requester pursuant to Rule 28(3) attached / Renonciation, sur document distinct, à l'engagement du requérant au titre de la règle 28(3)

30 ☐ Gemäß Regel 28(4) wird hiermit mitgeteilt, daß der Zugang zu dem in den Feldern 26 und 27 genannten biologischen Material nur durch Herausgabe einer Probe an einen Sachverständigen hergestellt wird / It is hereby declared under Rule 28(4) that the availability of the biological material referred to in Sections 26 and 27 shall be effected only by the issue of a sample to an expert / Conformément à la règle 28(4) il est déclaré par la présente que l'accessibilité à la matière biologique mentionée aux rubriques 26 et 27 ne peut réalisée que par la remise d'un échantillon à un expert

BIOM 3

31 Nucleotid- und Aminosäuresequenzen / Nucleotide and amino acid sequences / Séquences de nucléotides et d'acides aminés

SEQL 1

- ☐ Die Beschreibung enthält ein Sequenzprotokoll nach Regel 27a(1) / The description contains a sequence listing in accordance with Rule 27a(1) / La description contient une liste de séquences selon la règle 27bis(1)
- ☐ Der vorgeschriebene Datenträger ist beigefügt / The prescribed data carrier is enclosed / Le support de données prescrit est joint
- ☐ Es wird hiermit erklärt, daß die auf dem Datenträger gespeicherte Information mit dem schriftlichen Sequenzprotokoll übereinstimmt (Regel 27a(2)) / It is hereby stated that the information recorded on the data carrier is identical to the written sequence listing (Rule 27a(2)) / Il est déclaré par la présente que l'information figurant sur le support de données est identique à celle que contient la liste de séquences écrite (règle 27bis(2))

32 Benennung der Vertragsstaaten und Erklärungen hierzu / Designation of contracting states and associated declarations / Désignation d'Etats contractants et déclarations à ce propos

DEST

☒ 1. Hiermit werden sämtliche Vertragsstaaten des EPÜ benannt, die diesem bei Einreichung dieser Anmeldung angehören*. / All states which are contracting states to the EPC at the filing of this application are hereby designated*. / Sont désignés tous les Etats qui sont des Etats contractants de la CBE à la date du dépôt de la présente demande*.

☒ 2a. Es ist derzeit beabsichtigt, den **siebenfachen** Betrag einer Benennungsgebühr zu entrichten. Damit gelten die Benennungsgebühren für alle Vertragsstaaten als entrichtet (Art. 2 Nr. 3 GebO). / It is currently intended to pay **seven times** the amount of the designation fee. The designation fees for all the contracting states are thereby deemed to have been paid (Art. 2, No. 3, RFees). / Il est actuellement envisagé de payer un montant correspondant à **sept fois** la taxe de désignation. Les taxes de désignation sont ainsi réputées payées pour tous les Etats contractants (art. 2, point 3 du RRT).

☐ 2b. Abweichend von der Erklärung in Nr. 2a ist derzeit beabsichtigt, **weniger als sieben** Benennungsgebühren für folgende Vertragsstaaten zu entrichten *(bitte Ländercodes und Vertragsstaaten angeben*)*: / The declaration in No. 2a does not apply. Instead, it is currently intended to pay **fewer than seven** designation fees for the following contracting states *(please indicate country codes and contracting states*)*: / Contrairement à ce qui est indiqué au n° 2a, il est actuellement envisagé de payer **moins de sept** taxes de désignation pour les Etats contractants suivants *(prière d'indiquer codes de pays et Etats contractants*)* :

(1) ______

(2) ______

(3) ______

(4) ______

(5) ______

(6) ______

Es wird beantragt, für die unter Nr. 2b nicht aufgeführten Vertragsstaaten von der Zustellung von Mitteilungen nach Regel 85a(1) und Regel 69(1) abzusehen. / No communications under Rules 85a(1) or 69(1) need be notified in respect of the contracting states not indicated under No. 2b. / Prière de ne pas procéder à la signification des notifications prévues par les règles 85bis(1) et 69(1) pour les Etats contractants n'ayant pas été mentionnés au n° 2b.

☒ 3. Wird ein **automatischer Abbuchungsauftrag** erteilt (Feld 43), so wird das EPA beauftragt, bei Ablauf der Grundfrist nach Artikel 79(2) den siebenfachen Betrag einer Benennungsgebühr abzubuchen. Ist eine Erklärung unter Nr. 2b abgegeben worden, so sollen die Benennungsgebühren nur für die dort angegebenen Vertragsstaaten abgebucht werden, sofern dem EPA nicht bis zum Ablauf der Grundfrist ein anderslautender Auftrag zugeht. / If an **automatic debit order** has been issued (Section 43), the EPO is authorised, on expiry of the basic period under Article 79(2), to debit seven times the amount of the designation fee. If any states are indicated under No. 2b, the EPO shall debit designation fees only for those states, unless it is instructed to do otherwise before expiry of the basic period. / Si un **ordre de prélèvement automatique** est donné (rubrique 43), il est demandé à l'OEB de prélever, à l'expiration du délai normal visé à l'article 79(2), un montant correspondant à sept fois la taxe de désignation. Si une déclaration a été faite au n° 2b, les taxes de désignation ne sont prélevées que pour les Etats contractants qui y sont indiqués, sauf instruction contraire reçue par l'OEB avant l'expiration du délai normal.

* Stand bei Drucklegung: 24 Vertragsstaaten, und zwar: / Status when this form was printed: 24 contracting states, namely / Situation à la date d'impression : 24 Etats contractants, à savoir : **AT** Österreich / Austria / Autriche, **BE** Belgien / Belgium / Belgique, **BG** Bulgarien / Bulgaria / Bulgarie, **CH/LI** Schweiz und Liechtenstein / Switzerland and Liechtenstein / Suisse et Liechtenstein, **CY** Zypern / Cyprus / Chypre, **CZ** Tschechische Republik / Czech Republic / République tchèque, **DE** Deutschland / Germany / Allemagne, **DK** Dänemark / Denmark / Danemark, **EE** Estland / Estonia / Estonie, **ES** Spanien / Spain / Espagne, **FI** Finnland / Finland / Finlande, **FR** Frankreich / France / France, **GB** Vereinigtes Königreich / United Kingdom / Royaume-Uni, **GR** Griechenland / Greece / Grèce, **IE** Irland / Ireland / Irlande, **IT** Italien / Italy / Italie, **LU** Luxemburg / Luxembourg / Luxembourg, **MC** Monaco / Monaco / Monaco, **NL** Niederlande / Netherlands / Pays-Bas, **PT** Portugal / Portugal / Portugal, **SE** Schweden / Sweden / Suède, **SK** Slowakische Republik / Slovak Republic / République slovaque, **TR** Türkei / Turkey / Turquie

Verschiedene Anmelder für verschiedene Vertragsstaaten /
Different applicants for different contracting states /
Différents demandeurs pour différents Etats contractants

APPR 02 # 21085801 #

33 Name(n) des (der) Anmelder(s) und benannte Vertragsstaaten /
Name(s) of applicant(s) and designated contracting states /
Nom(s) du (des) demandeur(s) et des Etats contractants désignés

Mitsubishi Electric Information Technology Centre Europe B.V. - GB

Mitsubishi Denki Kabushiki Kaisha - All contracting states other than GB

34

Erstreckung des europäischen Patents

Diese Anmeldung gilt als Antrag, die europäische Patentanmeldung und das darauf erteilte europäische Patent auf alle Nicht-Vertragsstaaten des EPÜ zu erstrecken, mit denen am Tag ihrer Einreichung „Erstreckungsabkommen" bestehen (derzeit: Albanien, Litauen, Lettland, Rumänien, Slowenien, ehemalige jugoslawische Republik Mazedonien). Die Erstreckung wird jedoch nur wirksam, wenn die vorgeschriebene Erstreckungsgebühr entrichtet wird.

Extension of the European patent

This application is deemed to be a request to extend the European patent application and the European patent granted in respect of it to all non-contracting states to the EPC with which "extension agreements" exist on the date on which the application is filed (Present situation: Albania, Lithuania, Latvia, Romania, Slovenia, former Yugoslav Republic of Macedonia). However, the extension only takes effect if the prescribed extension fee is paid.

EXPT

☒ **Extension des effets du brevet européen**

La présente demande est réputée constituer une requête en extension des effets de la demande de brevet européen et du brevet européen délivré sur la base de cette demande à tous les Etats non parties à la CBE avec lesquels il existe un «accord d'extension» à la date du dépôt de la demande (Situation actuelle : Albanie, Lituanie, Lettonie, Roumanie, Slovénie, ex-République yougoslave de Macédoine). Toutefois, l'extension ne produit ses effets que s'il est acquitté la taxe d'extension prescrite.

Es ist derzeit beabsichtigt, die Erstreckungsgebühr für die nachfolgend angekreuzten Staaten zu entrichten: / It is currently intended to pay the extension fee for the states marked below with a cross: / Il est actuellement envisagé de payer la taxe d'extension pour les Etats dont le nom est coché ci-après :

Albanien / Albania / Albanie	AL	☐
Litauen / Lithuania / Lituanie	LT	☐
Lettland / Latvia / Lettonie	LV	☐
Rumänien / Romania / Roumanie	RO	☐
Slowenien / Slovenia / Slovénie	SI	☐
Ehemalige jugoslawische Republik Mazedonien / Former Yugoslav Republic of Macedonia / Ex-République yougoslave de Macédoine	MK	☐
		☐
		☐

(Platz für Staaten, mit denen nach Drucklegung dieses Formblatts „Erstreckungsabkommen" in Kraft treten) / (Space for states with which "extension agreements" enter into force after this form has been printed) / (Prévu pour des Etats à l'égard desquels des «accords d'extension» entreront en vigueur après l'impression du présent formulaire)

Die Anmeldung ist eine Teilanmeldung / The application is a divisional application / La présente demande constitue une demande divisionnaire

DFIL 9 #

PANR #

35 ☐ Nummer der früheren Anmeldung / No. of earlier application / Numéro de la demande initiale

Es handelt sich um eine Anmeldung nach Artikel 61(1)b) / The application is an Article 61(1)(b) application / La présente demande constitue une demande selon l'article 61(1)b)

DFIL 9 #

EANR #

36 ☐ Nummer der früheren Anmeldung / No. of earlier application / Numéro de la demande initiale

Patentansprüche / Claims / Revendications CLMS

37 16 Zahl der Patentansprüche / Number of claims / Nombre de revendications

Zur Veröffentlichung mit der Zusammenfassung wird vorgeschlagen Abbildung Nr. / It is proposed that the abstract be published together with figure No. / Il est proposé de publier avec l'abrégé la figure n° DRAW 2

39 13 Nummer / Number / Numéro

EPA/EPO/OEB Form 1001.4 07.02

J00045529EP

Raum für Zeichen des Anmelders / Space for applicant's reference / Espace réservé à la référence du demandeur

Zusätzliche Abschrift(en) der im europäischen Recherchenbericht angeführten Schriftstücke wird (werden) beantragt / Additional copy(ies) of the documents cited in the European search report is (are) requested / Prière de fournir une (des) copie(s) supplémentaire(s) des documents cités dans le rapport de recherche européenne ASOC	40	3 Anzahl der **zusätzlichen** Sätze von Abschriften / Number of **additional** sets of copies / Nombre de jeux **supplémentaires** de copies
Es wird die Rückerstattung der Recherchengebühr gemäß Art. 10 GebO beantragt / Refund of the search fee is requested pursuant to Article 10 of the Rules relating to Fees / Le remboursement de la taxe de recherche est demandé en vertu de l'article 10 du règlement relatif aux taxes	41	☐
Eine Kopie des Recherchenberichts ist beigefügt / A copy of the search report is attached / Une copie du rapport de recherche est jointe	42	☐

43

Automatischer Abbuchungsauftrag
(nur möglich für Inhaber von beim EPA geführten laufenden Konten)

Das EPA wird hiermit beauftragt, fällig werdende Gebühren und Auslagen nach Maßgabe der Vorschriften über das automatische Abbuchungsverfahren vom nebenstehenden laufenden Konto abzubuchen. In bezug auf die **Benennungsgebühren** wird auf Feld 32.3 verwiesen. Das EPA wird ferner beauftragt, die **Erstreckungsgebühren** für jeden in Feld 34 angekreuzten »Erstreckungsstaat« bei Ablauf der Grundfrist zu ihrer Zahlung abzubuchen, sofern ihm nicht bis dahin ein anderslautender Auftrag zugeht.

Automatic debit order
(for EPO deposit account holders only)

The EPO is hereby authorised, under the Arrangements for the automatic debiting procedure, to debit from the deposit account opposite any fees and costs falling due. With regard to **designation fees** reference is made to Section 32.3. The EPO is also authorised, on expiry of the basic period for its payment, to debit the **extension fee** for each of the "extension states" marked with a cross in Section 34, unless it is instructed to do otherwise before expiry of this period.

Ordre de prélèvement automatique
(possibilité offerte uniquement aux titulaires de comptes courants ouverts auprès de l'OEB)

Par la présente, il est demandé à l'OEB de prélever du compte courant ci-dessous les taxes et frais venant à échéance, conformément à la réglementation relative à la procédure de prélèvement automatique. Pour les **taxes de désignation,** se reporter à la rubrique 32.3. Il est en outre demandé à l'OEB de prélever, à l'expiration du délai normal prévu pour leur paiement, les **taxes d'extension** pour chaque «Etat autorisant l'extension» coché à la rubrique 34, sauf instruction contraire reçue avant l'expiration de ce délai.

Für automatischen Abbuchungsauftrag:
For automatic debit order:
Pour l'ordre de prélèvement automatique:

DECA

Nummer des laufenden Kontos / Deposit account number / Numéro du compte courant	Name des Kontoinhabers / Account holder's name / Nom du titulaire du compte

Eventuelle **Rückzahlungen** auf das nebenstehende beim EPA geführte laufende Konto / Any **reimbursement** to EPO deposit account opposite / **Remboursements** éventuels à effectuer sur le compte courant ci-contre ouvert auprès de l'OEB

DEPA

	Nummer des laufenden Kontos / Deposit account number / Numéro du compte courant	Name des Kontoinhabers / Account holder's name / Nom du titulaire du compte
44	2805.0072	RGC Jenkins & Co

45

Die vorgeschriebene Liste über die diesem Antrag beigefügten Unterlagen ergibt sich aus der vorbereiteten Empfangsbescheinigung (Seite 6 dieses Antrages)

The prescribed list of documents enclosed with this request is shown on the prepared receipt (page 6 of this request)

La liste prescrite des documents joints à cette requête figure sur le récépissé préétabli (page 6 de la présente requête)

46

Unterschrift(en) des (der) Anmelder(s) oder Vertreter(s) /
Signature(s) of applicant(s) or representative(s) /
Signature(s) du (des) demandeur(s) ou du (des) mandataire(s)

Für Angestellte nach Artikel 133(3) Satz 1 mit allgemeiner Vollmacht / For employees under Article 133(3), 1st sentence, having a general authorisation / Pour les employés mentionnés à l'article 133(3), 1ère phrase, munis d'un pouvoir général

Nr. / No. / n°:

Ort / Place / Lieu London, United Kingdom

Datum / Date 7 July, 2003

H Whitlock

Holly E. Whitlock
Authorised Representative

Name des (der) Unterzeichneten bitte in Druckschrift wiederholen. Bei juristischen Personen bitte die Stellung des (der) Unterzeichneten innerhalb der Gesellschaft in Druckschrift angeben. / Please print name under signature. In the case of legal persons, the position of the signatory within the company should also be printed. / Le ou les noms des signataires doivent être indiqués en caractères d'imprimerie. S'il s'agit d'une personne morale, la position occupée au sein de celle-ci par le ou les signataires doit être indiquée en caractères d'imprimerie.

J00045529EP
Raum für Zeichen des Anmelders / Space for applicant's reference / Espace réservé à la référence du demandeur

Empfangsbescheinigung / Receipt for documents / Récépissé de documents

(Liste der diesem Antrag beigefügten Unterlagen) (Checklist of enclosed documents) (Liste des documents annexés à la présente requête)

Es wird hiermit der Empfang der unten bezeichneten Dokumente bescheinigt / Receipt of the documents indicated below is hereby acknowledged / Nous attestons le dépôt des documents désignés ci-dessous

Wird im Falle der Einreichung der europäischen Patentanmeldung bei einer nationalen Behörde diese Empfangsbescheinigung vom Europäischen Patentamt übersandt, so ist sie als Mitteilung gemäß Regel 24(4) anzusehen (siehe Feld RENA). **Nach Erhalt der Mitteilung nach Regel 24(4) sind alle weiteren Unterlagen, die die Anmeldung betreffen, nur noch unmittelbar beim EPA einzureichen.** / If this receipt is issued by the European Patent Office and the European patent application was filed with a national authority it serves as a communication under Rule 24(4) (see Section RENA). **Once the communication under Rule 24(4) has been received, all further documents relating to the application must be sent directly to the European Patent Office.** / Si, en cas de dépôt de la demande de brevet européen auprès d'un service national, l'Office européen des brevets délivre le présent récépissé de documents, ce récépissé est réputé être la notification visée à la règle 24(4) (cf. rubrique RENA). **Dès que la notification visée à la règle 24(4) a été reçue, tous les autres documents relatifs à la demande doivent être adressés directement à l'OEB.**

Mr. Steven D. Burke,
RGC Jenkins & Co.,
26 Caxton Street,
London SW1H 0RJ,
United Kingdom.

J00045529EP
Mitsubishi Electric Information Technology
Centre Europe B.V. & Mitsubishi Denki K.K.

Nur für amtlichen Gebrauch / For official use only / Cadre réservé à l'administration

Datum / Date

THE PATENT OFFICE
VIII
07 JUL 2003
LONDON

Unter ... ature / Cachet officiel

Anmeldenummer / Application No. / N° de la demande			03254298.7
Tag des Eingangs (Regel 24(2)) / Date of receipt (Rule 24(2)) / Date de réception (règle 24(2))	DREC		07 JUL 2003
Zeichen des Anmelders/Vertreters / Applicant's/ Representative's ref. / Référence du demandeur ou du mandataire	AREF		J00045529EP
Nur nach Einreichung der Anmeldung bei einer nationalen Behörde: / Only after filing of the application with a national authority: / Seulement après le dépôt de la demande auprès d'un service national:			
Tag des Eingangs beim EPA (Regel 24(4)) / Date of receipt at EPO (Rule 24(4)) / Date de réception à l'OEB (règle 24(4))	RENA		

				Blattzahl* / Number of sheets* / Nombre de feuilles*	Gesamtzahl der Abbildungen* / Total number of figures* / Nombre total de figures*
A.	**Anmeldungsunterlagen und Prioritätsbeleg(e) / Application documents and priority document(s) / Pièces de la demande et document(s) de priorité**	47			
1.	Beschreibung (ohne Sequenzprotokollteil) / Description (excluding sequence listing part) / Description (sauf partie réservée au listage des séquences)		X	32	
2.	Patentansprüche / Claim(s) / Revendication(s)		X	4	
3.	Zeichnung(en) / Drawing(s) / Dessin(s) — DRAW 1 #		X	10	15
4.	Sequenzprotokollteil der Beschreibung / Sequence listing part of description / Partie de la description réservée au listage des séquences				
5.	Zusammenfassung / Abstract / Abrégé		X	1	
6.	Übersetzung der Anmeldungsunterlagen / Translation of the application documents / Traduction des pièces de la demande				
7.	Prioritätsbeleg(e) / Priority document(s) / Document(s) de priorité				
8.	Übersetzung des (der) Prioritätsbelegs(belege) / Translation of priority document(s) / Traduction du (des) document(s) de priorité				

* Die Richtigkeit der Angabe der Blattzahl und der Gesamtzahl der Abbildungen wurde bei Eingang nicht geprüft / No check was made on receipt that the number of sheets and the total number of figures indicated were correct / L'exactitude du nombre de feuilles et du nombre total de figures n'a pas été contrôlée lors du dépôt

B.	**Der Anmeldung in der eingereichten Fassung liegen folgende Unterlagen bei: / This application as filed is accompanied by the items below: / A la présente demande sont annexées les pièces suivantes:**	48	
1.	Einzelvollmacht / Specific authorisation / Pouvoir particulier		
2.	Allgemeine Vollmacht / General authorisation / Pouvoir général		
3.	Erfindernennung / Designation of inventor / Désignation de l'inventeur		X
4.	Früherer Recherchenbericht / Earlier search report / Rapport de recherche antérieure		
5.	Gebührenzahlungsvordruck (EPA Form 1010) / Voucher for the settlement of fees (EPO Form 1010) / Bordereau de règlement de taxes (OEB Form 1010)		
6.	Scheck *(nicht bei Einreichung bei den nationalen Behörden)* / Cheque *(not when filing with national authorities)* / Chèque *(pas de chèque en cas de dépôt auprès des services nationaux)*		
7.	Datenträger für Sequenzprotokoll / Data carrier for sequence listing / Support de données pour liste de séquences — SEQL 4		
8.	Zusatzblatt / Additional sheet / Feuille additionnelle		X
9.	Sonstige Unterlagen (bitte hier spezifizieren) / Other documents (please specify here) / Autres documents (veuillez préciser)		
C.	**Kopien dieser Empfangsbescheinigung / Copies of this receipt for documents / Copies du présent récépissé de documents**	49	4 — Anzahl der Kopien / Number of copies / Nombre de copies

FEES NOT PAID

Währung Betrag / Currency Amount / Monnaie Montant
(Ausfüllung freigestellt / optional / facultatif)

EPA/EPO/OEB Form 1001.6 07.02

J00045529EP
Raum für Zeichen des Anmelders / Space for applicant's reference / Espace réservé à la référence du demandeur

ADDITIONAL APPLICANT:

Applicant:	Mitsubishi Denki Kabushiki Kaisha,
Address:	2-3 Marunouchi 2-chome, Chiyoda-ku, Tokyo 100, Japan.
State of Residence:	Tokyo, Japan.
Nationality:	Japanese

ADDITIONAL REPRESENTATIVES

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James P.A. Cross

Timothy G. Pendered

Holly E. Whitlock

Mark Baldwin

Hugh C. Dunlop

Peter J.B. Gray

ERFINDERNENNUNG / DESIGNATION OF INVENTOR / DESIGNATION DE L'INVENTEUR

(falls Anmelder nicht oder nicht allein der Erfinder ist) / (where the applicant is not the inventor or is not the sole inventor) / (si le demandeur n'est pas l'inventeur ou l'unique inventeur)

Zeichen des Anmelders oder Vertreters Applicant's or representative's reference Référence du demandeur ou du mandataire (max. 15 Positionen / max. 15 spaces / 15 caractères au maximum)	Nr. der Anmeldung oder, falls noch nicht bekannt, Bezeichnung der Erfindung Application N° or, if not yet known, title of the invention N° de la demande ou, si ce dernier n'est pas encore connu, titre de ,invention
J00045529EP	GENERATION OF PACKETS OF WAVEFORMS

In Sachen der obenbezeichneten europäischen Patentanmeldung nennt (nennen) der (die) Unterzeichnete(n) [1]
In respect of the above European patent application I (we), the undersigned [1]
En ce qui concerne la demande de brevet européen susmentionnée le (s) soussigné(s) [1]

MITSUBISHI ELECTRIC INFORMATION TECHNOLOGY CENTRE EUROPE B.V.,
20 Frederick Sanger Road,
The Surrey Research Park,
Guildford, Surrey, GU2 7YD, U.K.

als Erfinder [2]:
do hereby designate as inventor(s) [2]:
désigne(nt) en tant qu'inventeur(s) [2]:

SZAJNOWSKI, Wieslaw Jerzy; of
3, The Red House, West Road, Guildford, Surrey, GU1 1AR, U.K.

☐ (Weitere Erfinder sind auf einem gesonderten Blatt angegeben) / (Additional inventors indicated on supplementary sheet) / (les autres inventeurs sont mentionnés sur une feuille supplémentaire).

Der (Die) Anmelder hat (haben) das Recht auf das europäische Patent erlangt [3]
The applicant(s) has (have) acquired the right to the European patent [3]
Le(s) demandeur(s) a (ont) acquis le droit au brevet européen [3]

☒ gemäß Vertrag vom under an agreement dated par contrat en date du	☐ als Arbeitgeber as employer(s) en qualité d'employeur(s)	☐ durch Erbfolge as successor(s) in title par transfert successoral

Ort/Place/Lieu LONDON, UNITED KINGDOM. Datum/Date 7 July, 2003

Unterschritt(en) des (der) Anmelder(s) oder Vertreter(s) /
Signature(s) of applicant(s) or representative(s) /
Signature(s) du (des) demandeur(s) ou du (des) mandataire(s)

H. Whitlock

Holly E. Whitlock, Authorised Representative

Name des (der) Unterzeichneten bitte mit Schreibmaschine wiederholen. Bei juristischen Personen bitte die Stellung des (der) Unterzeichneten innerhalb der Gesellschaft mit Schreibmaschine angeben / Please type name under signature in case of legal persons, the position of the signer within the company should also be typed / Le ou les noms des signataires doivent être également dactylographiés. S'il s'agit d'une personne morale, la position occupée au sein de celle-ci par le ou les signataires sera indiquée à la machine à écrire

Fußnoten befinden sich auf der Rückseite / Footnotes overleaf / Le texte des renvois figure au verso